

Divers Beware: Training Dives Present Serious Hazards to Fire Fighters

Summary

Fire fighters who participate in dive training risk lung damage, illness, or drowning. NIOSH investigated fatalities that have occurred during these training exercises and developed recommendations to decrease these risks.

Description of Exposure

Fire fighters may be called on to perform public safety diving actions, including search and rescue and recovery missions. Fire departments and fire fighters preparing for underwater operations must be aware that dive training can be hazardous. Diving hazards include entanglement, running out of air, lung overexpansion injury, panic attacks, and decompression sickness.

Entanglement in rope or aquatic plants is an extremely serious hazard that can prevent divers from returning to the surface [Hendrick et al. 2000].

Lung overexpansion most commonly occurs when divers panic and make rapid ascent holding their breath. No sensation of discomfort provides a warning when overexpansion is about to occur [NAUI 2000]. New divers may hold their breath when first learning to use SCUBA equipment [PADI 1990]. Lung overexpansion can result in pulmonary barotraumas causing serious damage to the lungs, including collapse [Bookspan 1995], even when ascending from relatively shallow depths and on relatively short dives.

Panic attacks while diving may be provoked by situations such as entanglement, running out of air, or reasons unknown. Panic attacks occur among both veteran and novice divers. Adequate attention to panic and anxiety attacks should be given during diver training. More than half of experienced divers surveyed report having panic episodes while SCUBA diving [Morgan 1995].

Decompression sickness (“the bends”) occurs after extended periods of time at depth followed by ascending too quickly, thus preventing nitrogen gas accumulated in the diver’s tissues from dissipating properly. Symptoms of decompression sickness can range from skin rash, extreme fatigue, coughing, and painful joints to paralysis and unconsciousness [NAUI 2000].

Case Studies

Case 1

On July 15, 1999, a 25-year-old male career fire fighter/paramedic/rescue diver drowned during a circular search training exercise at a lake [NIOSH 1999]. Acting as the pivot diver, the victim descended and maintained a fixed location while extending a length of rope to the pattern diver. The pattern diver swam increasingly larger circles around him while holding onto the rope.

About 2 minutes after the victim entered the water, his rope bag surfaced. The pattern diver surfaced and was instructed by the lead diver to retrieve the victim, but was unsuccessful. The boat driver radioed for emergency assistance. A rescue search was initiated, and the victim was found and brought to the surface. The victim's air regulator was not in his mouth and he was cyanotic and unresponsive. The victim was transported by helicopter to a regional trauma center, where he was pronounced dead. The cause of death was listed as drowning.

Case 2

On August 13, 2000, a 28-year-old male career fire fighter/SCUBA diver died during a search and rescue training exercise at a lake [NIOSH 2000]. During the exercise, a circular search pattern was used from a buoy line. The victim's partner lost the search line and became separated from the victim. The partner was equipped with a conventional regulator and had no electronic communications with the other divers.

Another diver saw the victim, who was distressed and frantically screaming and moving around, and knocked off the other diver's face piece. The victim, who was entangled in the buoy line, was pulled to the surface by the buoy line. The victim received medical assistance and

was then transported by helicopter to a nearby trauma center where he was pronounced dead. The cause of death was stated as pulmonary barotrauma.

Controls

To minimize the risk when participating in dive training, NIOSH recommends that fire departments and fire fighters take the following precautions:

Fire departments should do the following:

- Establish, implement, and enforce standard operating procedures (SOPs) regarding diver training.
 - Ensure that divers maintain positive communication with each other and with personnel who remain on the surface.
 - Develop a pre-dive checklist for all diving situations, including diver training, equipment function, and diver experience, which should match the difficulty of the intended dive.
 - Ensure that backup divers are trained to perform rescue operations for other divers who may be in distress.
 - Ensure that an experienced backup diver and a ninety-percent-ready diver are in position to help.
 - Provide divers with refresher training on the hazards and prevention measures of lung overexpansion injuries, entanglement, decompression, and panic attacks.
 - Practice the training exercise in a closed environment such as a swimming pool before attempting it in open water.
-

- Obtain and update appropriate medical fitness evaluations for SCUBA divers annually.
- Ensure that equipment checks are performed on a scheduled basis and defective equipment is repaired or replaced before a dive takes place.
- Supply divers with an alternative backup air source such as pony bottles.
- Ensure that instructors and divers are certified for SCUBA diving, dive training, and dive rescue operations by a nationally recognized organization.
- Ensure that a medical unit is on site with oxygen in case of an emergency.
- Ensure that dive coordinators stay informed about each diver's rate of air consumption.

Fire fighters/divers should do the following:

- Follow all SOPs.
- Maintain continuous visual, verbal, or physical contact with their dive partner.
- Perform equipment checks before each dive. Equipment checks should be verified by the dive coordinator.
- Ensure that underwater search teams operate individually to avoid rope entanglement.
- Regularly monitor their air consumption.
- Consider performing at least 12 dives per year to maintain skills.

REFERENCES

Bookspan J [1995]. Diving physiology in plain English. Kensington, MD: Undersea and Hyperbaric Medical Society, Inc.

Hendrick W, Zaferes A, Nelson C [2000]. Public safety diving. Saddle Brook, NJ: Fire Engineering Books and Videos.

Morgan WP [1995]. Anxiety and panic in recreational scuba divers. Sports Med 20(6):398-421.

PADI [1990]. PADI open water diver manual. Santa Ana, CA: Professional Association of Diving Instructors.

NAUI [2000]. NAUI scuba diver manual. Tampa, FL: National Association of Underwater Instructors.

NIOSH [1999]. Fire fighter/paramedic drowns during an underwater SCUBA training drill—Missouri. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 99F-29.

NIOSH [2000]. Fire fighter/SCUBA diver dies during training evolution—Indiana. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. F2000-38.

Additional resources regarding scuba diving include the following:

NFPA 1670—Standard on operations and training for technical rescue incidents.

NFPA 1006—Standard for rescue technician professional qualifications.

ACKNOWLEDGEMENTS

The principal contributors to this publication were Jay L. Tarley, Edward L. Husting, and Steven L. Proudfoot, Division of Safety Research, NIOSH.

For More Information

The information in this document is based on fatality investigations, literature and expert review. More information about the Fire Fighter Fatality Investigation and Prevention Program is available at www.cdc.gov/niosh/firehome.html

Contact the Divers Alert Network (DAN) 24 hour hotline at (919) 684-8111 in the event of a diving emergency or for questions about a diving injury.

To receive more information about occupational safety and health topics, contact NIOSH at

NIOSH
Publications Dissemination
4676 Columbia Parkway
Cincinnati, OH 45226-1998

Telephone: 1-800-35-NIOSH (1-800-356-4674)
Fax: 513-533-8573 ■ **E-mail:** pubstaff@cdc.gov

or visit the NIOSH Web site at www.cdc.gov/niosh

**Divers Beware: Training Dives Present
Serious Hazards to Fire Fighters**

For a monthly update on news at NIOSH, subscribe to **NIOSH eNews** by visiting www.cdc.gov/niosh/eNews.

Mention of any company or product does not constitute endorsement by NIOSH. In addition, citations to Web sites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. Furthermore, NIOSH is not responsible for the content of these Web sites.

This document is in the public domain and may be freely copied or reprinted. NIOSH encourages all readers of the Workplace Solutions to make them available to all interested employers and workers.

As part of the Centers for Disease Control and Prevention, NIOSH is the Federal agency responsible for conducting research and making recommendations to prevent work-related illnesses and injuries. All Workplace Solutions are based on research studies that show how worker exposures to hazardous agents or activities can be significantly reduced.

DHHS (NIOSH) Publication No. 2004-152

SAFER • HEALTHIER • PEOPLE™

June 2004

DEPARTMENT OF HEALTH AND HUMAN SERVICES

Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, OH 45226-1998

